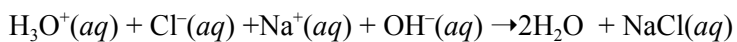


Neutralization Reactions

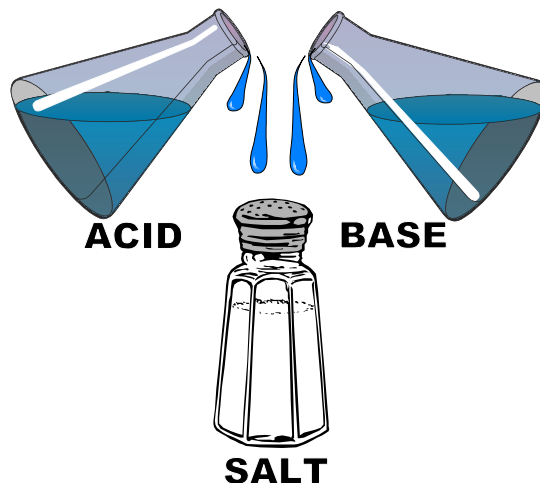
Acids and bases are opposites, so it makes sense that when they react together, the result is neutral. What happens during the chemical reaction that makes everything neutral? Technically, every acid base reaction is a double replacement reaction $[\text{HCl}(aq) + \text{NaOH}(aq) \rightarrow \text{NaCl}(aq) + \text{H}_2\text{O}(\ell)]$. Actually, it is a little more involved. Recall that acids ionize in water to produce hydronium ions $[\text{HCl}(g) + \text{H}_2\text{O}(\ell) \rightarrow \text{H}_3\text{O}^+(aq) + \text{Cl}^-(aq)]$. Bases, on the other hand, dissociate in water to release hydroxide ions $[\text{NaOH}(s) + \text{H}_2\text{O}(\ell) \rightarrow \text{Na}^+(aq) + \text{OH}^-(aq) + \text{H}_2\text{O}(\ell)]$. This means the double replacement reaction between $\text{HCl}(aq)$ and $\text{NaOH}(aq)$ really looks as follows:



Salt (NaCl) is an ionic compound. When it is placed in water, it dissociates $[\text{NaCl}(s) + \text{H}_2\text{O}(\ell) \rightarrow \text{Na}^+(aq) + \text{Cl}^-(aq)]$. This means, the complete reaction is $\text{H}_3\text{O}^+(aq) + \text{Cl}^-(aq) + \text{Na}^+(aq) + \text{OH}^-(aq) \rightarrow 2\text{H}_2\text{O}(\ell) + \text{Na}^+(aq) + \text{Cl}^-(aq)$.

The **highlighted** ions are exactly the same on both the product and reactant side of the equation. Because these ions did not actually participate in the reaction, they are called *spectator ions*. What is left,

$\text{H}_3\text{O}^+(aq) + \text{OH}^-(aq) \rightarrow 2\text{H}_2\text{O}(\ell)$, is the net reaction. Since the final product is water, the result is neutral.



Answer the questions below based on the reading above, and on your knowledge of chemistry.

- Complete and balance each of the acid base neutralizations below. Identify the spectator ions.
 - $\text{H}_2\text{SO}_4 + \text{Mg}(\text{OH})_2 \rightarrow$ _____
 - $\text{HNO}_3 + \text{Al}(\text{OH})_3 \rightarrow$ _____
 - $\text{H}_3\text{PO}_4 + \text{Ca}(\text{OH})_2 \rightarrow$ _____
 - $\text{HI} + \text{KOH} \rightarrow$ _____
 - $\text{HBr} + \text{Ba}(\text{OH})_2 \rightarrow$ _____
- How are the net reactions for each of the examples above similar? _____

- The definition of neutralization is a reaction between an acid and a base to produce a salt and water. Where does the salt come from in the neutralization reaction? _____
- Where does the water come from in a neutralization reaction? _____

- What occurs during a neutralization reaction that causes the end product to be neutral? _____
